TECHNICAL TRAINING BY TELEVISED INSTRUCTION

UNITED STATES AIR FORCE
AIR TRAINING COMMAND
LOWRY TECHNICAL TRAINING CENTER
DENVER, COLORADO

September 1966

History (The Early Days):

Lowry Technical Training Center, located at Denver, Colorado, is one of the United States' Air Force Air Training Command Centers. It was selected in 1958 as the initial Air Training Command Center to apply educational television (ETV) to technical training needs.

ETV, while relatively new in comparison with conventional training methods, can no longer be considered experimental. Civilian institutions have been performing training by television for years, and portions of many courses between kindergarten and college graduation are now offered in this way.

The significant aspects of Lowry's approach to ETV has been the degree of emphasis placed upon the medium itself. That is, television has been and is being used at Lowry, not as a periodic supplement to normal training methods, but as the central method. Television has not been inserted into the existing training procedures, but rather those courses selected for televised presentation have been completely revised in approach and organization to permit television to be utilized fully and effectively. Traditional methods, to the extent that they have been retained, are present not because they are traditional but because they still work effectively in an ETV milieu. Television at Lowry, then, is used not as a periodic supplementary technique but as the central method of instruction; whenever a course is selected for televised presentation there is no subject matter area of that course which is not presented in some degree by televised instruction.

The original course chosen for televised presentation in 1958 was the MA-6A, MA-7A Bomb Navigation Systems Mechanic Course (Number ABR32130E). This course was the initial selection for television because of its length (720 academic hours), its content (basic electronic fundamentals through system troubleshooting of an electro-mechanical computer and an associated radar set), and its student entry (basic airman through master sergeants, retraining into the 32 career field). Because of its length, its diverse content and its varied student entry, this course was very representative of the type of technical training the Air Force does, and it was considered to be an excellent trial balloon for televised training techniques.

Initially, the use of ETV seemed promising as a means for minimizing or offsetting a basic and serious training problem: the shortage of qualified instructors. This problem exists in any training institution, but in military training situations, it seems particularly severe. Due to discharge, reassignment and transfer of instructor personnel, it is always difficult to retain the truly trained and experienced instructor. He is constantly being replaced by younger, less skilled men. Studies conducted at Lowry indicated that, at any given moment, some 20% of the instructor staff was fully qualified in terms of both classroom and field experience. The remaining 80% were somewhere between the extremes of newly-assigned and nearly-qualified. Due to the continuous instructor turnover rate, this ratio held consistently true in spite of continuous and extensive instructor cross training programs.

The problem, then was how to best utilize the available highly qualified 20% of the faculty. ETV seemed to offer a solution. It was presumed that if these 20% were placed in the television studio, there would be no limit to the number of students they could reach --- in effect they could do 100% of the teaching job. This would have the effect of stabilizing training quality and raising it to the highest level, instead of accepting the lesser average point. The remaining 80% of the instructor staff remained in the classroom with the students and these less-skilled instructors took care of the normal, routine duties of the classroom but were not required to carry the main body of the teaching burden. It was presumed that their instructional skill or relative lack of it, would not have as great an effect on the quality of ETV training as it would on the quality of conventional training.

It was not intended by this plan that these lesser-skilled instructors would be shunted aside for it was recognized that an important aspect of the plan would be that these instructors would be receiving training along with their students. The students would be learning the subject matter while the instructors would be learning <u>what</u> to teach, and most important they would be learning <u>how</u> to teach by observing highly <u>skilled</u> instructors doing the job the way it should be <u>done</u> over television.

To a great degree these initial suppositions were empirically supported, but one basic philosophical modification has resulted from Lowry's ETV experience. The view of the respective roles of the Studio Instructor and the Classroom Instructor has been changed. Initially it has been assumed that the difference between these two would be merely a matter of <u>degree</u> of skill. Now it appears that the difference is a difference in the <u>kind</u> of skill required.

In technical training (indeed in any kind of training) there are two important aspects of communication; the transmission and inculcation of <u>knowledges</u> and of <u>skills</u>. There is no clear dichotomy between these goals and their associated methods, nor can these two sides of the coin be regarded as independent aspects of the training situation. It was recognized at Lowry that the televised instruction portion of the training day is primarily efficient in the presentation of the knowledges, while the laboratory period of the day is mainly skill-oriented. This is not to suggest any separation of these goals, however; the televised lesson is effective in previewing and clarifying the laboratory work, just as the laboratory projects are effective in reviewing and strengthening the theoretical content of the televised lesson.

As this difference in prime purpose was noted, however, it became necessary to review the initial rationale. Another important factor became apparent at the same time: the Studio Instructor deals with the students en masse, while the Classroom Instructor deals with them on a nearly individual basis.

It became apparent then that the Studio and Classroom Instructors must vary in type rather than degree. They must both be regarded as specialists doing a specific and unique portion of the total teaching job. The question of superiority or inferiority of the importance of these two functions is irrelevant. Present televised techniques at Lowry note and follow this view. This viewpoint has resulted from experience, but it should be noted that the first efforts in televised training at Lowry were conducted under the premise that the Classroom Instructor was in an apprentice category and that the main teaching burden rested with the Studio Instructor.

A secondary premise had been that the demonstration aspects of technical training would benefit greatly from the use of ETV. This has proven to be the case. In the classroom, when demonstrating a small piece of equipment or a complex procedure, the instructor encounters many difficulties. It is difficult if not impossible, to arrange equipment so that a large group of students can all see it. The usual solution to this problem is to build large mock-up models of the equipment. All of the students can see these mock-ups, but they are expensive to build, difficult to store, and usually do not actually work. On television, the actual equipment itself is shown in operation, and all students can see it clearly and simultaneously. The use of close-up lenses means that items can be shown larger than life size.

In the classroom if actual equipment is to be demonstrated and it is tiny or hard to see, the instructor has to take the students through the demonstration individually or in small groups. The disadvantages here are obvious. A single demonstration may have to be repeated several times before all members of the class have seen it. This is wasteful of time and reduces training quality; if an instructor has to repeat the same thing over and over again, he's seldom doing a good job of it the last few times. On television, the instructor demonstrates to the camera and only once. Whatever the camera sees can be simultaneously seen by any number of students with extreme clarity and no loss of time. As a result, all group demonstrations are presented over television rather than in the laboratory or classroom area.

Further, Lowry decided to approach televised training from a production viewpoint. This means making full use of all available studio techniques; close-ups, fades, superimpositions, special effects, audio effects, zoom lenses, dollying, panning, special lighting effects, etc. So-called "minimal" television techniques, where a camera is merely placed in a front row seat of a classroom and used to televise normal classroom procedures, would expand the size of the audience that can be reached, but it was felt that they would not reach that enlarged audience with the full force and effect available from the television medium.

In the early televising of the ABR32130E Course, Lowry's students had a 6-hour academic day, divided up approximately into one third television and two thirds laboratory work. During the first couple of hours, the students watched their television monitors in the classroom. Frequent breaks were provided, and the maximum length of televised viewing at one sitting was 50 minutes. It was common, however, for the student to see one fifty minute televised lesson followed by a 10 or 15 minute break and another 50 minute televised lesson before beginning his laboratory work. In these lessons, the Studio Instructor discussed, explained and demonstrated in detail the equipment that the students would be working on. During the remaining four hours of the day the students performed their laboratory work, under the monitorship and guidance of the Classroom Instructor, and repeated the procedures that had been demonstrated and discussed on television.

During the laboratory period the Classroom Instructor worked closely with the students, identifying individual confusions and clarifying them. He answered student questions, based on his knowledge of the course content and his knowledge of the student as an individual learner.

By contrast, in the conventional instructional methods for the course, students spent their first three hours reading and discussing a prepared, written lesson. The Classroom Instructor would demonstrate the equipment, discuss it and illustrate it on his blackboard. Following this presentational discussion period, the laboratory period began and it was essentially the same as the television laboratory period.

The major distinction between the two methods was in the manner in which information was presented to the student. The television student received all of his technical information over television and with maximum visual impact; the conventional student received all of his technical information in the form of printed lessons which he read and then discussed with his Classroom Instructor. Television at Lowry, in 1958, was not being used simply to supplement classroom instruction, but to replace a portion of it with what was felt to be a more effective method.

While Lowry has always been interested in experimentation with techniques and methods, it has never been in a valid research situation---the main mission has always been to train its students as effectively as possible, and the control and manipulation of their training which would be essential to carefully controlled studies has not been applied. At each point, in its development of ETV techniques, Lowry has attempted to analyze its results; however, this analysis has been restricted to available empirical data and not based on carefully structured experimental situations.

During the televised presentation of the ABR32130E Course, entering students were divided into two groups. These groups were matched as nearly as possible on the basis of individual student aptitudes, age, and educational background prior to entry into the Air Force. These matched classes were closely observed; the same tests were given both groups and the results were tabulated and analyzed. While the quantity of data obtained never reached statistically significant proportions, certain trends seemed apparent:

ETV students learned more and learned more thoroughly.

ETV students were better prepared to begin their laboratory periods, and made more effective use of them.

ETV produced savings in the total training time required; the TV students learned faster and the TV method saved time.

(The time saving aspect of ETV had not been anticipated. Initially, it had been hoped that there would be an increase in training quality and while this was found to be the case, there had been no plan to shorten training time by the use of ETV.)

The next phase of Lowry's ETV efforts consisted of a 20% shortening of the televised course. Again comparisons were made with students being trained conventionally at the original time length and students being trained at 80% of the original time by means of ETV. The ETV students were found to have learned more even in this shorter period of time.

History (The Transition):

In 1959, it became apparent that the number of graduates in the ABR32130E Career Field would soon reach the Air Force requirement for that particular specialty and the course itself would be placed on standby for a brief period of time. Lowry officials concluded that the efficacy of ETV having been demonstrated, its benefits should be retained and the scope of its application should be expanded. The Center was conducting a basic Fundamentals of Electronics Course (ABR3202O) which had a heavy student flow and which was the prerequisite course to twenty-six specific equipment courses also taught at Lowry. Since the original ABR32130E course contained an extensive electronic fundamentals subject area, it was decided to revise this portion of the course slightly and televise basic electronics alone.

Lowry's TV equipment and studio facilities were not at that time large enough to completely assume the training burden in the ABR32030 Course; however, in March of 1960, the studios were fully utilized in the training of one-third of the students in that course. Every third class was trained by ETV at an accelerated rate, while the other two classes were trained by conventional means at the normal course rate.

Again, the possibility of comparative studies existed and they were conducted. As usual, it was found that even at the accelerated rate the ETV students graduated with a greater degree of both knowledge and retention.

During this period, Lowry began enlarging its TV facilities to the point where all students in the ABR32020 Course could be trained by ETV. In March of 1962 the entire student entry in the ABR32020 Course began to receive training by means of ETV. The course, which had formerly required 19 academic weeks for conventional presentation was televised in a course of 15 weeks duration. Students in this basic course were shredded out at various points within the course, depending on the amount of electronic fundamentals they needed as a prerequisite to their specialized system course.

For example, the student assigned to become a mechanic on a relatively simple system left the ABR32020 Course after 4 weeks of televised instruction and began conventional training which was oriented to his specific system. On the other hand, a student who had been selected to study a highly complex radar and computer would take the entire 15 weeks of the televised ABR32020 Course before entering into specialized system training.

By televising this course, which is a common prerequisite to 26 specialized courses, a much larger number of Lowry students were able to receive the benefits of televised training.

The ABR32020 Course was later expanded and became a 17 week course. This expansion was due to the inclusion of additional subject matter on solid state electronics and related areas; subject matter not contained in the 15 week version. This specific course has now been phased out at Lowry and replaced with an ATC Standardized Electronic Principles Course which will be discussed in detail later.

Equipment and Facilities:

There are two studios located in Building 999 and three broadcast quality videotape recorders. Additionally, in the film projection area, there are three multiplexers used in support of the studios and five uniplexers used to play video film recordings for the classroom areas. Building 999 also houses a video film recorder, associated film processing facilities and other TV support activities. (See drawing -- following page)

The receiving area is Building 903, located some distance away. It is equipped with fifty-two ETV receiving classrooms. The six video cables between buildings 999 and 903 permit the simultaneous transmission of six different televised lessons.

Building 903 has a local distribution center which enables any given incoming program from one of the six cables to be routed to the appropriate classroom area for student viewing.

Program Scheduling:

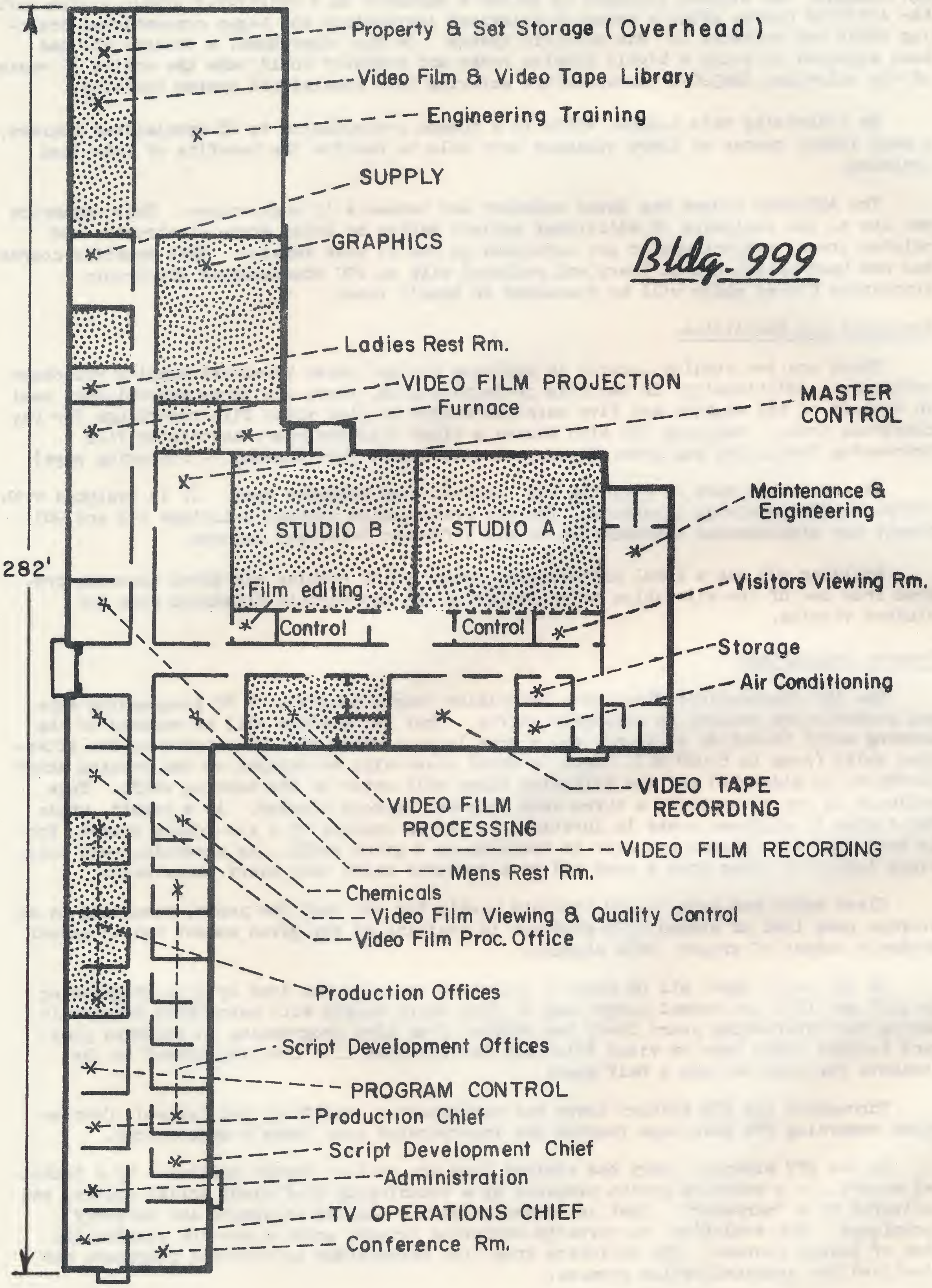
The ATC Standardized Electronic Principles Course consists of 90 programming days, and students are entered on alternate shifts. That is, a class will be entered on the morning shift (6:00A.M. to noon), and a week later a class will be entered on the afternoon shift (noon to 6:00P.M.). Next, a third class will be entered on the evening shift (6:00P.M. to midnight) and the following class will enter on the morning shift. This produces on any given shift a three week interval between classes. As a result, while the course is eighteen weeks in duration, it can be handled by a six-source output, for no more than six classes are ever in training on a given shift. As a result, each televised lesson is shown once a week and on a specific shift once every three weeks.

Class entry has been 75-100 students weekly for the past few years, resulting in an average peak load of around 1300 students in training at any given moment and an annual graduate output of around 4000 students.

In its early days, all of Lowry's televised training was done by live programming. In 1958 and 1959 the normal output was 90 live hours weekly with associated rehearsals. During the intervening years Lowry has shifted from live programming to recorded playback (either video tape or video film) and has not done live training direct to the students for over two and a half years.

Throughout its ETV history Lowry has experimented, modified, and revised. Conclusions regarding ETV have been reached and incorporated into Lowry's methodology.

In its ETV history, Lowry has evolved from the outline script delivered by a technical expert, to a verbatim script prepared by a technically proficient script writer, and delivered by a "narrator" - that is, a man primarily skilled in speech and delivery techniques. The evolution to verbatim scripting brought about a precise standardization of lesson content. The evolution from live productions to recorded playbacks has finalized the standardization process.


Property & Set Storage (Overhead)
Video Film & Video Tape Library
Engineering Training
SUPPLY
GRAPHICS
Bldg. 999
Ladies Rest Rm.
VIDEO FILM PROJECTION
Furnace
MASTER CONTROL
Maintenance & Engineering
STUDIO B
STUDIO A
282'
Film editing
Control
Control
Visitors Viewing Rm.
Storage
Air Conditioning
VIDEO TAPE RECORDING
VIDEO FILM PROCESSING
VIDEO FILM RECORDING
Mens Rest Rm.
Chemicals
Video Film Viewing & Quality Control
Video Film Proc. Office
Production Offices
Script Development Offices
PROGRAM CONTROL
Production Chief
Script Development Chief
Administration
TV OPERATIONS CHIEF
Conference Rm.

Each lesson is carefully prepared, rehearsed and recorded. From that point on content, sequence, pace and timing, the use of illustrations, demonstrations, etc., are all fixated and standardized. Each successive class receives exactly the same training as did the previous one. It may be noted that this standardizing effect is utilized to insure proper and full subject coverage; it has not been allowed to retard course improvement, as lessons are revised, improved and re-recorded continuously, based on test results, student reaction, changes in subject matter, etc.

Specialization of Function: This is perhaps the most important factor in determining the improved quality and efficiency possible through the use of ETV. In conventional classroom instruction, we really require a "jack of all trades", for the instructor must be able to do several things exceedingly well if he is to teach exceedingly well. We require him to plan and organize his approach to the specific training subject, to assemble and arrange his own demonstrators and training aids, to select or prepare his own illustrations as he goes along, to be an effective and motivational public speaker, to be capable of both mass and individualized instruction, to be a laboratory technician, to prepare test items and administer tests, to counsel his students and determine individual weaknesses and deficiencies and to conduct remedial training as appropriate to each student's needs.

Manifestly, we rarely find an individual who possesses all of these talents at the same high level. We may for example, find an instructor who is an excellent speaker and gives highly motivational lectures but who falls short in his ability to illustrate what he is saying pictorially. Not to belabor the point, suffice it to say that each and every individual instructor is just that, an individual --- he has strong points and weak points.

The use of ETV, permits us to operate a highly effective training program without reliance on a basically superhuman and generally non-available instructor. We can break this formerly complex but individualized task down into its component parts and assign these component specialties to a team of specialists. For example, in ETV the scriptwriter must have an ability to write clearly and forcefully. His ability or inability as a public speaker is not a factor. The illustrator must have the ability to portray concepts in interesting and clear graphic form --- his technical competence is not an essential factor in that the nature of the illustration and their technical accuracy is the responsibility of the scriptwriter.

The on-camera narrator does not have to select the sequence and content of what he is about to say, nor the illustrations that will be used in support of it --- he must be first and foremost a public speaker and he can concentrate his full efforts on that portion of the task --- the delivery of someone else's message. (Incidentally, notwithstanding the well demonstrated efficiency of using "actors" in technical training films, there seems to be a general tendency to feel that in ETV the man on camera should be technically proficient and preferably the greatest technical expert available. Lowry, conversely, feels that it is preferable to have a "narrator" delivering a message he does not fully understand but which is technically correct, than to have an unquestioned technical expert who is a poor or marginal speaker delivering the message. The net effect, from the students' viewpoint, is a clear preference for and a greater degree of learning from the narrator delivery of a message prepared by a technical expert.)

The contribution made by the production team members is a highly specialized function which contributes greatly to the general result. The Classroom Instructor, is freed of a great part of his "traditional" function and can concentrate on those which fall uniquely into his province. These are the introduction and motivation for the televised lesson, a discussion (not a lecture) following it, and the conduct of the associated laboratory period during which he provides individualized instruction to meet individual student needs.

The point is that the use of ETV permits the dissection of the total teaching job into its separate functions and the assignment of those functions to separate specialists who are uniquely qualified to perform them at a high level; the resultant televised lesson is far greater than the sum of its parts and always better than the training produced by the average Classroom Instructor carrying the entire burden alone.

Question and Answer System: Initially, a question and answer system was provided so the students could ask questions of their Studio Instructor. This, of course, is only feasible when the Studio Instructor is a technical expert. Students in the classroom raised their hands in the normal way and the Classroom Instructor threw a switch which lighted a number in the studio. The Studio Instructor knew that he had a question and the room from which it was originating. He asked for that question when it was convenient to him. The student stated his question into a microphone and the Television Instructor heard it on a loudspeaker in the studio. All of the classrooms receiving that particular program heard the student's question and the instructor's answer.

It was soon determined, however, that the question and answer system was neither as helpful nor as necessary as originally supposed. Careful analysis of questions asked by students revealed that slightly over 70% of them were anticipatory; that is, if the student had held his question, the Television Instructor would have answered it in a few more minutes anyhow.

Another twenty percent were irrelevant to the topic and merely served to disrupt orderly development of the subject. The remaining 10% were relevant and served as important indicators of obscure deficient areas in the script.

Lowry's first modification in the question and answer technique was to defer questions until the end of the lesson. This reduced the quantity of questions to a 10% figure as compared to the original frequency. Still it was found that the answering of student questions was a difficult task for the Studio Instructor, particularly as the number of students increased. Perhaps the heart of the problem was that during the question and answer period, the Studio Instructor who is best equipped for mass communication, found himself trying to operate on an individual student basis. At best, the process was unwieldy; at its worst, it was intolerable.

Obviously, the process of student question and answer interchange with his instructor is totally related with live presentation. You cannot ask a question of a recording. Lowry no longer uses the question and answer system for two reasons: (1) Because its gains were minor compared to its inconveniences and disadvantages and (2) because all Lowry televised training is now accomplished by playback from recordings.

Two-Way Communication in Troubleshooting: The existence of a two-way audio system between the classroom and the studio can be justified on an entirely different basis and in a different application. In troubleshooting phases of systems courses, the Studio Instructor can insert certain malfunctions (unknown to the students) into the equipment and let the students observe how the equipment behaves. By means of the two-way communication system, the students can direct the instructor's activities. They tell the instructor what voltages to check, what meters to read, what adjustments to make, etc. Instead of passively observing, the students actively participate. This results in a much greater degree of student involvement, a new sense of active participation, and far greater enthusiasm and interest on the part of the student. The instructor guides their activities by asking questions, summarizes results, and corrects incorrect approaches, but he does not dominate this procedure. This use of two-way communication was found to be very effective in the televised presentation of the original ABR32130E Course. Its use, of course, required the existence of a two-way audio system and live presentation; however, both might be justified on this basis alone--- where student participation, instructor guided but not dominated, is desirable as a learning experience. Again, this requires the use of a technically proficient on-camera instructor.

Recording Capability: Lowry is equipped to make its own video film and video tape recordings. Both methods are used because of certain advantages which are peculiar to each. The general advantages of recording have been already discussed, but there is one other aspect worthy of consideration. This is lesson distribution. Having achieved, polished and perfected a successful lesson on some subject, there remains the possibility that the same training is being laboriously duplicated elsewhere. The existence of video film and video tape recordings of this lesson establish a means of distributing this lesson to other users for their training needs. Both methods of recording have been used for specific local advantage --- for example. the great benefit with video tape recording is the immediacy of its playback. The instructor can view his own performance within minutes of its completion and this has an obvious advantage for self-critique purposes. Also errors detected can be immediately corrected before the production team has gone to other duties and before the studio set and lighting have been rearranged for another program. Video tape, however, is not easily distributable because of the specialized and relatively expensive playback equipment required.

The video film recorder produces, as an end product, a sixteen millimeter sound film. This recording is easily distributable because it can be played back on any sixteen millimeter sound projector---an audio-visual aid which is relatively cheap and widely available. (However, the video film recording involves some time lag for the photographic processes of development, sound-on-film reproduction, sound synchronization, print production, etc. These necessary delays are significant factors in their value for instructor-self-critique purposes. True, the instructor is able to critique himself with a video film recording, but the time lag between the actual performance and the playback for self-analysis does reduce the usefulness of the video film recording as a self-critique item.)

Lowry uses both types of recording because of their specific advantages both in program review and self-critique and in program distribution to other users of the lessons.

THE ATC STANDARDIZED ELECTRONICS PRINCIPLES COURSE (ETV):

Lowry completed the production of the first four blocks of the ATC Standardized Course in August of 1964 and began actual student use of the course immediately. This course is strikingly different from the one it replaced in terms of development, approach, technique, and quality control.

The Air Training Command, recognizing that there is a great need for standardized training in basic electronic principles, established a Working Group with membership from the five technical training centers (Lowry, Keesler, Chanute, Amarillo, Sheppard) to develop a standardized electronic principles course for televised presentation at all five centers.

In effect, ATC proposed ETV to eliminate duplication of effort in a central area of subject matter common to all training centers and to establish an ETV network based not on simultaneous programming but upon interchange of video tape and video film recordings.

The first ATC Working Group meeting was held at ATC Headquarters 25-27 September 1962. During that meeting and subsequent ones, the questions of course content and sequence were established. The result was the 18 week course shown in the following course chart.

(NOTE: This course chart shows academic weeks vertically. Each academic week consists of five 6-hour days. Blocks of instruction vary in length; for example, Block I is three weeks long or 90 academic hours. The subjects covered in each block are listed in sequence with their time durations indicated.)

TABLE III - COURSE CONTENT - COURSE CHART AQR 32020

WEEKS \ HOURS PER DAY	1 2 3 4 5 6
1	**Course Material - UNCLASSIFIED** 90 Hours BLOCK I - DC Circuits
2	Orientation and study habits (2 hrs); Safety and first aid (1 hr); Electrostatic principles (3 hrs); Fundamentals of DC (24 hrs); Series resistive circuits (12 hrs); Parallel resistive circuits (12 hrs); Series-parallel resistive circuits (9 hrs); Resistive bridge circuits (6 hrs); Principles of magnetism, relays and vibrators (9 hrs); Meter movements and circuits (6 hrs); Measurement and critique (6 hrs).
3	
4	**Course Material - UNCLASSIFIED** 90 Hours BLOCK II - AC Circuits
5	Generation of AC and DC (6 hrs); Frequency spectrum (3 hrs); Inductance, inductive reactance and transformers (9 hrs); Capacitance and capacitive reactance (6 hrs); Use of the oscilloscope (9 hrs); Series RC, RL, RCL and resonance (24 hrs); Parallel RC, RL, RCL and resonance (18 hrs); Solid state diodes and rectifier circuits (9 hrs); Measurement and critique (6 hrs).
6	
7	**Course Material - UNCLASSIFIED** 60 Hours BLOCK III - Solid State Devices
8	Filters and power supplies (9 hrs); Transistor triodes and special purpose devices (15 hrs); Amplifier principles (9 hrs); Audio amplifiers (6 hrs); Push-pull amplifier (6 hrs); Video amplifiers (3 hrs); Voltage regulators (6 hrs); Measurement and critique (6 hrs).
9	**Course Material - UNCLASSIFIED** 60 Hours BLOCK IV - Vacuum Tubes Diodes and rectifier circuits (6 hrs); Triodes (12 hrs); Amplifier principles (3 hrs); Audio Amplifiers (3 hrs); Tetrodes, pentodes and multipurpose tubes (3 hrs); Video amplifiers (3 hrs); Cathode-ray and special purpose tubes (6 hrs); Gas tubes (3 hrs); Voltage regulators (3 hrs); Handtools, soldering techniques and kit construction (6 hrs); Cathode followers (6 hrs); Measurement and critique (6 hrs).
10	

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TABLE III – COURSE CONTENT – COURSE CHART AQR 32020

HOURS PER DAY / WEEKS	1 2 3 4 5 6
11 12	Course Material - UNCLASSIFIED 60 Hours BLOCK V - Oscillators Limiter and clamper circuits (9 hrs); RF and IF amplifiers (6 hrs); Oscillators (27 hrs); Amplitude modulation (6 hrs); Detection (6 hrs); Measurement and critique (6 hrs).
13 14	Course Material - UNCLASSIFIED 60 Hours BLOCK VI - Receiver Principles Synchroscope (3 hrs); Heterodyning (6 hrs); Schematic interpretation and troubleshooting (15 hrs); Frequency modulation (6 hrs); Discrimination (6 hrs); Single sideband (3 hrs); Transmission lines (9 hrs); Antennas (6 hrs); Measurement and critique (6 hrs).
15	Course Material - UNCLASSIFIED 30 Hours BLOCK VII - Motors and Servomechanisms Saturable reactors and magnetic amplifiers (6 hrs); Motors (6 hrs); Synchros (6 hrs); Servomechanisms and Servo amplifiers (9 hrs); Measurement and critique (3 hrs).
16 17	Course Material - UNCLASSIFIED 60 Hours BLOCK VIII - Waveshaping Circuits Transients (9 hrs); Blocking Oscillators (5 hrs); Pulsed oscillators (4 hrs); Free running multivibrators (6 hrs); One-shot multivibrators (6 hrs); Bi-stable multivibrators (6 hrs); Phantastron circuit (6 hrs); Sawtooth generators (6 hrs); trapezoidal generators (6 hrs); Measurement and critique (6 hrs).
18	Course Material - UNCLASSIFIED 30 Hours BLOCK IX - Microwave Principles Artificial lines (3 hrs); Pulse amplitude modulation (6 hrs); Doppler principles (3 hrs); Waveguides (6 hrs); Cavity resonators (3 hrs); UHF and microwave oscillators (4 hrs); Magnetrons (3 hrs); Measurement and critique (2 hrs).

PLAN OF INSTRUCTION (Continued)

(A) STATEMENT OF LEARNING OBJECTIVES	(B) DURATION (HOURS)	(C) TRAINING STANDARD CORRELATION: STUDY REFERENCES: EQUIPMENT & TRAINING AIDS; INSTRUCTIONAL GUIDANCE
		Discussion: 15 min Drill: 30 min TV-117C (30 min) Obj: DC-4 j(2) (Cont'd) SSG/SWB: DC-4Q Discussion: 15 min Drill: 28 min
k. Ohm's Law (1) Writes the three expressions of Ohm's Law. (2) Solves for voltage (E) applied to a simple resistive DC circuit when the current and resistance values are given. (3) Solves for current (I) in a simple resistive DC circuit when the applied voltage and resistance values are given. (4) Solves for resistance (R) in a simple resistive DC circuit when the applied voltage and current are given. (5) Demonstrates application of Ohm's Law by changing values of E and R in a circuit and measuring the results with the ammeter, ohmmeter, and voltmeter.	(1 hr. 23 min)	TV-118 (20 min) Obj: DC-4 k(1) through (4) SSG/SWB: DC-4R Obj: DC-4 k(5) --- Non TV Discussion: 15 min TV-118 1 (9 min) Drill and Lab: 36 min Equipment: Multimeter Multipurpose Trainer
6. DC-5, Series Resistive Circuits	12 hrs	(Day 6)
a. Circuit Analysis (1) States the requirements for a series circuit. (2) States the rules for current and voltage distribution in a series DC resistive circuit. (3) Writes the formulas for total resistance, total current, and total voltage: (a) $R_t = R_1 + R_2 + R_3$ (b) $I_t = I_1 + I_2 + I_3$	(2 hrs, 19 min)	TV-119A (39 min) Obj: DC-5 a(1) through (3) SSG/SWB: DC-5A Obj: DC-5 a(4) --- Non TV Discussion: 20 min TV-119 1 (10 min) Drill and Lab: 70 min Equipment: Multimeter Trainer, VOM Operation

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The course consists of nine blocks of instruction which will be used in varying degrees at the centers depending upon the specific needs of the students. That is, as usual, students will enter the course and take as much of the course as is considered necessary to prepare them for their following specialized training. Some students will take the course in its entirety; other students will shred out at earlier points in the course.

Having established the desired content and sequence for the standardized course, the Working Group next began to spell out specific objectives. Here, again, was a departure from the traditional in that these objectives were spelled out not by listing subject coverage, but rather by describing student behavior. Rather than describing the training process, the objectives described the training product. The plan of instruction for the standardized course, then, became more a description of the graduating student's capabilities than a description of his learning experiences. In essence, it was a description of what we were after rather than how it was to be achieved. The sample from the Plan of Instruction for Block I on the opposite page illustrates the point.

The first column (Column A) is headed "Statement of Learning Objectives". Instead of simply listing the subject, "Ohm's Law", the Working Group described the desired student behavior to result from his exposure to Ohm's Law. For example Item k(1) states "Write the three expressions of Ohm's Law". Each of these statements of learning objectives can be mentally prefaced with the words "The student---" and become a statement of student behavior.

The Working Group development of student behavioral objectives which were observable and more importantly, measurable opened the door to actual testing of student achievement of these objectives and testing of the effectiveness of the associated TV lesson.

At this point, the Working Group decided that some criterion of lesson effectiveness should be established. It was concluded that each TV lesson would be acceptable for use in all five centers when it had been tested on a group of students and the students as a group had achieved a score of 90-80%. That is, when tested against the objectives covered by the lesson, 90% or more of the students must score 80% or higher on the criterion test. It was further decided that the criterion test would be conducted on no less than 45 students and preferably on larger groups. The Working Group also decided that no televised lesson would run over 40 minutes in duration.

Having decided on the specific subject content and sequence of the standardized course, and having established student behavioral objectives, as well as precise criteria of achievement, production assignments for the televised portions of the course were made by ATC.

Lowry was assigned production responsibility for the first four blocks (10 weeks) of the course and Keesler Technical Training Center was assigned responsibility for the televised production of the last five blocks (8 weeks) of the course. Both centers were to select those objectives they felt suitable for televised presentation, develop a televised lesson not to exceed 40 minutes in length, criterion test that lesson against the objectives it covers, and achieve a score of no less than 90-80% on the criterion test.

Referring again to the sample page from the Plan of Instruction, Column B indicates that Lowry will devote 1 hour and 23 minutes to the teaching of objective k, Ohm's Law.

Column C shows the breakdown of this one hour and twenty-three minutes. TV lesson number TV-118 is twenty minutes long. This lesson covers objectives DCk(1) thru (4). That is, it teaches the student to accomplish tasks 1 through 4 in Column A. There is an associated Student Study Guide and Student Workbook numbered DC-4R. The student will read the study guide portion before coming to class and will see the TV lesson after which he will perform the student workbook laboratory projects. Notice that objective k(5) is not televised. This is an objective that requires student use of equipment and while it can be demonstrated, its achievement is based on actual student practice and must ultimately depend on the laboratory period for achievement. Eighteen minutes are devoted to discussion between the students and the classroom instructor and forty five minutes are devoted to drill and laboratory work. Equipment required for the laboratory work is a multimeter and Lowry's multipurpose trainer.

When TV Lesson 118 had been initially written, illustrated, rehearsed and videotaped, it was subjected to criterion testing on actual students. The criterion test for this lesson was determined by the nature of the objectives themselves. The test required the students to

(1) Write the three expressions of Ohm's Law,

(2) Solve for voltage in a simple resistive DC circuit when current and resistance values are given,

(3) Solve for current in a similar situation,

(4) Solve for resistance in a simple resistive DC circuit.

Note that the criterion test is an exact duplication of the behavior implied in the objective itself. For example, the objective

"Write the three expressions of Ohm's Law"

cannot be precisely measured by a multiple choice type test item. Multiple choice would require the student to select or identify the three expressions of Ohm's Law --- a different behavior from that of writing.

This general pattern was followed throughout the criterion testing program. The action verb in the objective determines the nature of the test item. It may be interesting to note that Lesson Nr TV-118 was tested on 102 students and the group score was 97-80%. That is, 97% of the test group scored 80% or higher on the criterion test --- the actual student average score on the criterion test was 95%.

The criterion test scores were achieved by testing the lesson in isolation from any other aspect of teaching. Students in the present course were located at that point in the course where they had studied the necessary prerequisite subjects but had not begun their study of the specific subject under test. The Classroom Instructor did not introduce or teach the subject; the students were simply shown the TV lesson. The students had not read the student study materials prior to seeing the TV lesson. Immediately after the TV lesson was shown and without classroom discussion, the students were tested. It is with a fair degree of confidence, then, that we feel the criterion test scores reflect the quality of the TV lesson alone without contamination from other training procedures.

Following this general process, between March of 1963 and August of 1964, Lowry produced 122 criterion-tested televised lessons in support of the first four blocks of the standardized course. In addition, they prepared the associated student study materials to support these televised lessons.

The following summary shows in concise form the substance of this ETV production effort and the criterion testing program.

(See pages 16, 17 and 18)

Advantages of Criterion Testing:

It is felt that the criterion testing approach has much to offer educational technology. The televised lessons in the standardized course are out of the realm of subjective evaluation. Each lesson has been checked, evaluated and certified. As long as the student body receiving training by these lessons remains similar to the student body upon which they were tested, the same results can be expected time after time. We have then, not a series of lessons where there is only an indication of subject coverage, but a series of lessons which can guarantee delivery of a specific level of efficiency in the achievement of a specific set of objectives.

Programmed ETV:

Operating within the ATC ground rules for time length and lesson effectiveness, each producing center was given a local option as to procedure --- the ETV method to be used was not specified in advance so long as the final lesson met ATC's criteria.

Lowry elected to incorporate programmed instructional techniques into its approach. The courses conducted at Lowry during previous years were more or less conventional TV courses in that they were conducted mainly by televised, student-passive lectures and demonstrations. In its production of the ATC Standardized Course, Lowry decided to apply certain programmed instructional techniques and to increase the degree of student involvement and participation in the lesson itself.

Specifically, the televised programs were arranged so that

(1) Information was presented in small increments,

(2) Student participation was elicited early in each lesson and throughout each lesson,

(3) Student participation was structured to be in the main successful and within the student's ability at any given response point,

(4) The student was asked to make responses to the lesson contents and granted time for those responses and

(5) The student was immediately informed of what each response should have been.

While it cannot be statistically demonstrated or proven, Lowry feels that while a great deal of the effectiveness of its standardized televised lessons accrues from its use of ETV itself, a significant part of their high quality can be attributed to the use of programmed instructional techniques.

BLOCK I

TV LESSON NUMBER	TITLE	NR OF STUDENTS TESTED	CRITERION TEST RESULTS	AVG GRADE	LESSON RUNNING TIME
TV-104	Atomic Structure	47	91-80	93	30
TV-105	Conductor and Insulator	65	96-80	98	18
TV-106	Charged Bodies	71	96-80	93	29
TV-108A	DC Parameter	69	98-80	97	35
TV-108B	DC Parameter	69	98-80	96	19
TV-109A	Resistors	61	98-80	98	20
TV-109B	Resistors	61	91-80	92	38
TV-110A	Basic Circuit Symbols and Components	51	96-80	98	32
TV-110B	Basic Circuit Symbols and Components	98	95-80	95	23
TV-112	Ohmmeter	84	98-80	98	37
TV-113	Voltmeter	101	94-80	99	38
TV-114	Ammeter	88	98-80	98	30
TV-116A	Powers of Ten	84	94-80	94	25
TV-116B	Powers of Ten	84	92-80	92	28
TV-116C	Powers of Ten	78	91-80	88	40
TV-116D	Powers of Ten	83	91-80	92	34
TV-117A	Simple Equations	93	91-80	94	36
TV-117B	Simple Equations	90	91-80	97	18
TV-117C	Simple Equations	74	91-80	91	30
TV-118	Ohm's Law	102	97-80	95	20
TV-119A	EIR in Series R	88	92-80	88	39
TV-119B	EIR in Series R	88	91-80	92	18
TV-121	Power in Series R	92	93-80	91	29
TV-122	Troubleshooting (Series R)	78	97-80	93	35
TV-123	Voltage Doublers	75	91-80	90	27
TV-124	Rheostats Pots	81	96-80	94	23
TV-126A	EIR in Parallel R	90	94-80	95	33
TV-126B	EIR in Parallel R	79	97-80	98	24
TV-126C	EIR in Parallel R	91	99-80	94	33
TV-128	Power in Parallel R	85	94-80	93	21
TV-129	Troubleshooting Parallel R	82	91-80	89	24
TV-131A	EIR in Series Parallel	95	91-80	92	40
TV-133	Loaded Voltage Div	95	93-80	94	33
TV-134A	Bridge Circuits	52	91-80	96	32
TV-134B	Bridge Circuits	53	100-80	97	26
TV-135A	Magnetism	83	98-80	90	34
TV-135B	Magnetism	75	99-80	97	34
TV-136	Electromagnetism	72	92-80	93	25
TV-137	Relays	73	100-80	99	18
TV-138	Vibrators	101	97-80	97	25

BLOCK II

TV LESSON NUMBER	TITLE	NR OF STUDENTS TESTED	CRITERION TEST RESULTS	AVG GRADE	LESSON RUNNING TIME
TV-200	AC	64	90-80	92	39
TV-201A	AC Generators	51	96-80	91	29
TV-201B	AC Generators	51	97-80	92	24
TV-202	DC Generators	72	95-80	94	30
TV-204A	Frequency Spectrum	86	94-80	97	16
TV-204B	Wavelength	84	93-80	91	26
TV-204C	Calculations	84	92-80	89	30
TV-205A	Inductance	70	92-80	90	30
TV-205B	Inductance	50	100-80	98	19
TV-206A	Inductive Reactance	65	96-80	96	24
TV-206B	Inductive Reactance	65	91-80	92	25
TV-207	Transformers	83	92-80	92	30
TV-209	Capacitance	66	100-80	99	38
TV-210A	Series and Parallel Capacitance	90	92-80	97	20
TV-210B	Capacitive Reactance	84	93-80	93	26
TV-214	Graphing Series RCL	53	91-80	85	39
TV-216	Trigonometry, Series RCL	57	93-80	91	40

BLOCK II (Cont'd)

TV LESSON NUMBER	TITLE	NR OF STUDENTS TESTED	CRITERION TEST RESULTS	AVG GRADE	LESSON RUNNING TIME
TV-218	Power and Power Factor	76	93-80	89	34
TV-220A	Series Resonance	82	100-80	97	24
TV-220B	Series Resonance	76	100-80	100	29
TV-220C	Series Resonance	67	91-80	94	32
TV-221	Q, Frequency Response	60	92-80	93	39
TV-222	Parallel RC (Vector)	82	99-80	95	30
TV-224	Parallel RC (Trig)	77	91-80	88	39
TV-229A	Parallel RCL	82	100-80	96	29
TV-229B	Parallel RCL	82	98-80	98	27
TV-231A	Solid State Principles	59	97-80	94	25
TV-231B	Solid State Principles	58	91-80	90	15
TV-232	Solid State Diodes	74	92-80	91	27
TV-234	Metallic Rectifiers	76	92-80	96	19
TV-235A	Rectifiers	86	97-80	95	32
TV-235B	Rectifiers	75	99-80	92	30
TV-236	Bridge Rectifiers	86	100-80	99	34
	BLOCK III				
TV-300A	Filter Action	78	99-80	97	27
TV-300B	Filter Action	76	97-80	98	18
TV-301A	Types of Filters	69	93-80	92	26
TV-301B	Types of Filters	71	99-80	99	27
TV-303	Power Supplies	62	92-80	92	38
TV-304	Power Supply Troubleshooting	62	97-80	95	26
TV-307	Voltage Doubler	100	98-80	97	36
TV-309	Transistor Triodes	93	99-80	99	16
TV-310	Bias I	89	92-80	95	27
TV-312	Bias II	98	91-80	92	27
TV-314	Transistor Triode Operation	98	100-80	95	21
TV-316	Common Base Configuration	98	92-80	91	29
TV-317	Common Emitter Configuration	76	92-80	92	40
TV-318	Common Collector Configuration	76	92-80	91	40
TV-319	Transistor Triode Characteristics	68	98-80	93	26
TV-321	Transistor Tetrode	80	94-80	94	29
TV-323A	Amplifier Principles	87	97-80	97	30
TV-323B	Amplifier Principles	89	100-80	98	20
TV-324A	Coupling	97	94-80	92	27
TV-324B	Coupling	97	92-80	95	25
TV-325	Distortion	97	96-80	92	37
TV-327A	Audio Amplifiers	69	100-80	99	21
TV-327B	Audio Amplifiers	69	100-80	99	34
TV-328A	Push-Pull Amplifiers	97	97-80	98	29
TV-328B	Push-Pull Amplifiers	97	95-80	95	28
TV-329	Video Amplifiers	73	99-80	97	39
TV-331	Voltage Regulators	71	93-80	95	15
	BLOCK IV				
TV-400A	Diode Tubes (Emission)	89	100-80	99	34
TV-400B	Diode Tubes (Space Chg)	88	99-80	90	36
TV-402	Half-Wave Rectifiers	73	100-80	97	23
TV-403	Full-Wave Rectifiers	77	95-80	96	32
TV-404	Bridge Rectifiers	76	100-80	98	26
TV-405	Voltage Doublers	95	95-80	97	28
TV-407A	V T Triode Construction	89	100-80	100	10
TV-407B	V T Triode Construction	89	93-80	93	22
TV-408	Bias I	96	94-80	94	18
TV-409	Bias II	96	94-80	95	17
TV-410	Bias III	96	99-80	98	27
TV-414	Amplifier Principles	82	98-80	97	35

BLOCK IV (Cont'd)

TV LESSON NUMBER	TITLE	NR OF STUDENTS TESTED	CRITERION TEST RESULTS	AVG GRADE	LESSON RUNNING TIME
TV-415	Audio Amplifiers	95	98-80	94	28
TV-416	Push-Pull Amplifiers	94	99-80	99	30
TV-419	Pentodes and Pentagrids	96	95-80	94	28
TV-421	Video Amplifiers	46	92-80	89	29
TV-422	Special Purpose Tubes	95	95-80	91	18
TV-425	Electrostatic CRT	95	100-80	98	38
TV-429	Gas tubes	67	98-80	98	26
TV-430	VR Tubes	66	96-80	93	18
TV-431	Electronic Voltage Regulator	66	94-80	89	36
TV-434	Cathode Followers	89	93-80	95	37

Summary by Averages:	Nr. Stu. Tested	Test Score	Average Score
BLOCK I	80.65	94.575-80%	94.175
BLOCK II	72.21	94.818-80%	93.515
BLOCK III	82.85	95.851-80%	95.148
BLOCK IV	84.31	96.681-80%	95.181
Overall	79.51	95.303-80%	94.393

Average Lesson Length - 28 minutes

Present and Future:

Since August of 1964, Lowry has had a dual ETV function:

(1) The programing of the ATC Standardized Course on an 18-hour per day basis, with peaks of 6 simultaneous lessons.

(2) The preparation of televised presentations in support of command-wide needs.

In this latter function, Lowry is now supporting such diverse training areas as: medical service training, pharmaceutical training, preventive medicine, flying training, weather training, computer training, missile training, field training, command and staff briefings, etc.

Lowry's fulfillment of this mission is under the direct monitorship and control of Headquarters, Air Training Command (ATTTS-V) which receives requests for televised lessons in accordance with the procedures described in AFR 100-1/ ATCSUP1. Upon ATC approval of and priority assignment to televised projects, Lowry TV stands ready to assist all command training activities by bring the benefits of ETV to bear upon their training problems.

Lowry Technical Training Center-TV conducts a continuing self-analysis program, constantly reviewing and weighing its goals and achievements. Throughout its history, this program has been the past basis for planning current operations and is the present basis for planning future operations. Lowry's approach to televised training has been and continues to be flexible and eclectic, and, it is hoped that this will enable the future development of broadened and expanded TV applications, techniques and improved procedures for the utilization of the television medium.

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